PATENT ABSTRACTS OF JAPAN

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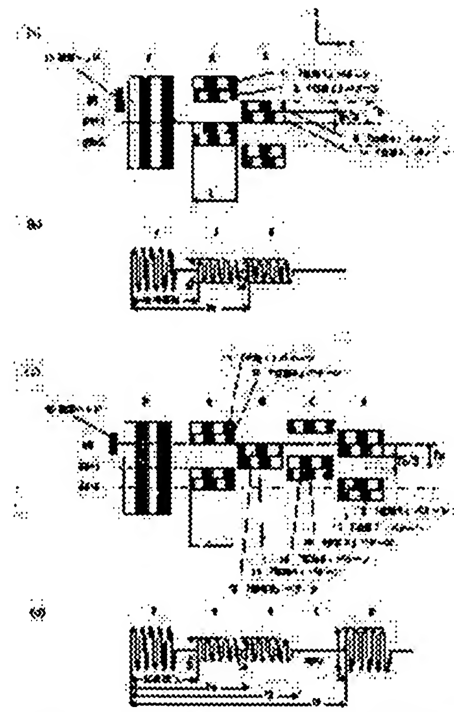
(54) MAGNETIC STORAGE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a improved method and device than a conventional system to a main cause of obstructing increase in track density.

SOLUTION: A servo pattern is constituted of plural patterns arranged on both sides of a track central line while shifting in the track direction, and respective patterns A, B are constituted so that respectively two kinds of phase state patterns 11, 12, 13, 14 are arranged in the track width direction. A sine wave function nearly coinciding with a servo pattern regenerative signal waveform is obtained based on frequency information of a beforehand held regenerative signal, and a magnetic head signal is demodulated.



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CLAIMS

[Claim(s)]
[Claim 1] The magnetic-recording medium which has a servo pattern, and the magnetic head which performs writing and read-out of information to said magnetic-recording medium, In magnetic storage including the servo signal demodulator circuit which recovers a magnetic-head position signal from the regenerative signal of said servo pattern The regenerative signal of said servo pattern includes two or more partial signals with which the amplitude and a phase change to coincidence according to the truck cross direction location of said magnetic head. Said servo signal demodulator circuit is magnetic storage characterized by restoring to said magnetic-head position signal in quest of the abbreviation coincidence sine wave [each / of two or more of said partial signals] function based on the frequency information on said regenerative signal currently held beforehand.
[Claim 2] It is the magnetic storage characterized by for said servo demodulator circuit asking for the amplitude of each partial signal by adding integral processing to the partial signal concerned in magnetic storage according to claim 1, and asking for a phase from the phase of said sinusoidal function.
[Claim 3] It is the magnetic storage characterized by said servo demodulator circuit asking for the amplitude and phase of each partial signal from said sinusoidal oscillation of a function and phase in magnetic storage according to claim 1.
[Claim 4] It is the magnetic storage characterized by giving different weight to the information for which said servo demodulator circuit is obtained from the amplitude in magnetic storage according to claim 1, 2, or 3, and the information acquired from a phase, and restoring to said magnetic-head position signal.
[Claim 5] Magnetic storage characterized by obtaining the velocity vector of said magnetic head using two magnetic-head position signals which only predetermined distance left in the direction of a truck in the magnetic storage of claim 1-4 given in any 1 term.
[Claim 6] The magnetic-recording medium which has a servo pattern, and the magnetic head which performs writing and read-out of information to said magnetic-recording medium, In magnetic storage including the servo signal demodulator circuit which recovers a magnetic-head position signal from the regenerative signal of said servo pattern Said two or more patterns are magnetic storage characterized by arranging the pattern of two kinds of phase conditions crosswise [truck], and being constituted including two or more patterns which shifted said servo pattern in the direction of a truck on both sides of a truck center line, and have been arranged, respectively.
[Claim 7] The magnetic-recording medium which has a servo pattern, and the magnetic head which performs writing and read-out of information to said magnetic-recording medium, In magnetic storage including the servo signal demodulator circuit which recovers a magnetic-head position signal from the regenerative signal of said servo pattern Said two or more patterns are magnetic storage characterized by arranging the pattern of the phase condition of N (N is three or more positive numbers) class crosswise [truck], and being constituted including two or more patterns which shifted said servo pattern in the direction of a truck on both sides of a truck center line, and have been arranged, respectively.
[Claim 8] The magnetic-recording medium which has a servo pattern, and the magnetic head which performs writing and read-out of information to said magnetic-recording medium, In magnetic storage including the servo signal demodulator circuit which recovers a magnetic-head position signal from the regenerative signal of said servo pattern said servo pattern Said two or more patterns are magnetic storage with which the phase condition of the direction of a truck is characterized by being the pattern which changes crosswise [truck] continuously, respectively including two or more patterns shifted and arranged in the direction of a truck on both sides of a truck center line.
[Claim 9] The magnetic-recording medium which has a servo pattern and was divided crosswise [truck] in two or more zones, In the magnetic storage which includes informational writing, the magnetic head which performs read-out, and the servo signal demodulator circuit which recovers a magnetic-head position signal from the regenerative signal of said servo pattern to said magnetic-recording medium The regenerative signal of said servo pattern includes two or more partial waves from which the amplitude and a phase change to coincidence according to the truck cross direction location of said magnetic head. The frequencies of said servo pattern regenerative signal differ for said every zone. Said servo signal demodulator circuit is magnetic storage characterized by restoring to said magnetic-head position signal in quest of the abbreviation coincidence sine wave [each / of two or more of said partial signals] function based on the frequency information on said servo pattern regenerative signal read from the inside of each zone.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to magnetic storage and relates to magnetic storage which acquires the information for positioning the magnetic head from the regenerative signal of the servo pattern especially recorded on the magnetic disk, such as a flexible mold magnetic disk drive and a rigid mold magnetic disk drive.
[0002]
[Description of the Prior Art] By carrying out alternate arrangement of the servo bit for every predetermined truck spacing like the publication to JP,47-32012,B most generally, and the servo pattern for positioning the magnetic head of magnetic storage reproducing the each, and comparing an amplitude difference, the positional information of the truck cross direction is acquired and the method of positioning the magnetic head (tracking) is learned.
[0003] Drawing 2 is drawing explaining the outline of the conventional "amplitude detection servo" method. Drawing in which drawing 2 (a) shows the relation between a truck and a servo pattern, and drawing 2 (b) are drawings showing an example of the regenerative signal acquired from the magnetic head which moves in a servo pattern top. The case where the magnetic head 10 of the width of recording track Twr is positioned to truck #N is considered. As shown in drawing 2 (a), when the magnetic head 10 advances in the x directions of drawing and Pattern P and A-D are passed, a regenerative signal as shown in drawing 2 (b) is acquired. Here, it expresses that P, the white part of each pattern of A-D, and a black part have respectively the mutually reverse sense of magnetization of the servo pattern recorded on the magnetic-recording medium. That is, if the sense of magnetization of a white part and a black part is a vector which has the direction (x directions) component of a truck in a medium side and which turned to hard flow mutually if it is the magnetic recording within a field, and it is vertical recording, the sense of magnetization of a white part and a black part is the vector with a component perpendicular to a medium front face which turned to hard flow mutually. Moreover, the pattern of drawing 2 (a) is a mimetic diagram, and in agreement with the signal cycle of drawing 2 (b) in fact.
[0004] If SA-SB which is the difference of the regenerative-signal amplitude SA of Pattern A and the regenerative-signal amplitude SB of Pattern B is calculated and the magnetic head 10 is moved crosswise [truck / y], the result of an operation will serve as N-POS shown in the right of drawing 2 (a). If similarly SC-SD which is the difference of the regenerative-signal amplitude SC of Pattern C and the regenerative-signal amplitude SD of Pattern D is calculated and the magnetic head 10 is moved crosswise [truck / y], the result of an operation will serve as Q-POS shown in the right of drawing 2 (a). The current position of the magnetic head 10 can be known by using suitably the signal of N-POS and Q-POS which were calculated above as a position signal.
[0005] The method which "phase detection servo" Becomes as a servo system different from the above on the other hand is indicated by JP,60-10472,A. Drawing 3 is drawing explaining the outline of the conventional "phase detection servo" method. The case where the magnetic head 10 of the width of recording track Twr is positioned to truck #N is considered. The magnetic head 10 advances in the x directions, and when passing the pattern P shown in drawing 3 (a), and A-C, a regenerative signal as shown in drawing 3 (b) is acquired. Here, the notation of P, the white part of each pattern of A-C, and a black part is the same as that of drawing 2 . Although the azimuth attaches the pattern to the magnetic head 10, since the include angle is small to extent from which degradation (azimuth loss) of a regenerative signal does not pose a problem, the configuration of each regenerative signal hardly changes to drawing 2 . However, the phase of each patterns A, B, and C to Pattern P changes with locations of the truck cross direction y, and sets the phase in #N truck to PA, PB, and PC here, respectively. Here, the pattern of drawing 3 (a) is a mimetic diagram, and in agreement with the signal cycle of drawing 3 (b) in fact.
[0006] When difference PB-PA of each phase and PC-PB are calculated now, this result of an operation in the truck cross direction y becomes what was shown in the right of drawing 3 (a) as an example. The current position of the magnetic head 10 can be known by using suitably the signal of PB-PA and PC-PB which were calculated above as a position signal. In addition, as an approach of asking for phases PA, PB, and PC from the regenerative signal of drawing 3 (b), the approach currently indicated by JP,6-231552,A can be used, for example.
[0007] Moreover, the example which combines the approach of making a wave distorted to an amplitude pattern and detecting time amount change of the wave-like part to it is indicated by JP,9-251736,A. The pattern with which this pattern includes the time amount change property that in addition to the property of the conventional amplitude pattern a wave-like part does not change but another part changes is recorded. C of drawing 2 and D pattern are omissible with this pattern.
[0008]
[Problem(s) to be Solved by the Invention] The technical or various factors on magnetic-storage production actualize as a factor which checks the increment in track density as the track density of magnetic storage increases. among those, about the geometric factor resulting from the width of recording track and the servo pattern configuration of the magnetic head, it appears in the form of the non-linearity of a position signal -- it comes. In this, a record pattern writes crosswise [truck], it reads, and it spreads or the effectiveness to carry out is included [**** / spread]. Moreover, about a record medium and the noise of a regenerative-circuit system, it looks relatively as a fall of a signal-to-noise ratio (S/N) to a regenerative signal. Furthermore, to the vibration (disturbance vibration) from the outside, the amount of [by the head point-to-point-control system] flattery remainder arrives at the limitation of track density by exceeding the amount which it has as allowances (margin).

[0009] Moreover, in the conventional example which combines the approach of making a wave distorted to an amplitude pattern and detecting time amount change of the wave-like part to it, since another harmonic content in addition to the harmonic content in a fundamental wave or the wave before making it distorted occurs as a result of making a wave distorted, there is a fault which a recovery noise increases. This invention is made in view of the above point, and it aims at offering the approach improved more as compared with the present method to the inhibition factor of the above-mentioned increment in track density, and equipment.
[0010]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, in this invention, the servo pattern information for positioning the magnetic head or positional information is multiplexed. That is, improvement in location precision is aimed at by using it effectively, acquiring to coincidence the amplitude information and topology which a servo pattern has, and making it complement mutually.
[0011] Generating the non-linearity of a position signal especially in an amplitude detection method by the mismatching of the width of face of a servo pattern and the reproducing-head width of recording track is admitted. However, the nonlinear location which is easy to generate is restricted to the local part. On the other hand, the topology which cannot produce non-linearity easily is acquired collectively, and if it is used complementing amplitude information and topology, the nonlinear problem of a position signal will become avoidable.
[0012] By using it about a position signal noise combining the above-mentioned amplitude information and topology, amount of information is more substantial and effectiveness is large to improvement in signal S/N. Detecting positional information to disturbance vibration, it is also acquiring the rate information on the head of the truck cross direction from topology, for example, when disturbance vibration is large, it becomes possible in an early phase to stop record actuation.
[0013] Here, as a means to acquire amplitude information from a servo pattern playback wave, full wave rectification of the above-mentioned signal is carried out, and there is a method of next performing an integration operator. The result (amplitude value) obtained here reflects the amplitude value of a servo pattern regenerative signal. As another means, servo pattern playback wave information is incorporated discretely, and there is the approach of acquiring by reexpressing by the fourier polynomial. This approach is described in detail below. As a means to acquire topology from a servo pattern playback wave, servo pattern playback wave information is discretely incorporated like the above, and the approach of acquiring by reexpressing by the fourier polynomial is used. Below, the approach is described.
[0014] The above-mentioned servo pattern playback wave is a repeat covering a certain number cycle of the regular wave, and sets N and the above-mentioned number of repeats of position signal wave p (n) to L for the number (exaggerated measurement size) discretely incorporated to per [one cycle (period)]. However, n is the number of the point incorporating [wave]. It will be set to the following [several 1] if p (n) is expressed with the fourier polynomial representation. In addition, in accordance with the wave-like frequency to incorporate, it is necessary to decide the frequency of a sampling (discrete incorporation). In other words, it has wave-like frequency information in the form of a sampling frequency beforehand.
[0015]
[Equation 1]

$$p(n) = A_0 + \left[\sum_{m=1}^{\frac{N}{2}-1} \left\{ A_m \cdot \cos\left(\frac{2 \cdot n \cdot \pi \cdot m}{N} \right) + B_m \cdot \sin\left(\frac{2 \cdot n \cdot \pi \cdot m}{N} \right) \right\} \right]$$

[0016] Here, discretization Fourier coefficients and m of A0, Am, and Bm are the degrees of the discretization Fourier transform. If discretization Fourier coefficients are decided, it will be decided that the above-mentioned fourier polynomial will be a meaning. If the sampling data of a pattern playback wave are set to f (n), Fourier coefficients will be called for as shown in following [several 2], [several 3], and [several 4].
[0017]
[Equation 2]

$$A_0 = \frac{1}{L \cdot N} \sum_{n=0}^{L \cdot N-1} f(n)$$

[0018]
[Equation 3]

$$A_m = \frac{2}{L \cdot N} \sum_{n=0}^{L \cdot N-1} f(n) \cdot \cos\left(\frac{2 \cdot n \cdot \pi \cdot m}{N} \right)$$

[0019]
[Equation 4]

$$B_m = \frac{2}{L \cdot N} \sum_{n=0}^{L \cdot N-1} f(n) \cdot \sin\left(\frac{2 \cdot n \cdot \pi \cdot m}{N} \right)$$

[0020] A required result can be most easily obtained by calculating the primary fourier coefficient A (m= 1) 1 and B1. Here, in amplitude detection, amplitude value is calculated as the following [several 5], and, in phase detection, the phase contrast from a reference pattern is searched for as the following [several 6].
[0021]
[Equation 5]

$$\sqrt{(A_1)^2 + (B_1)^2}$$

[0022]
[Equation 6]
$$\arctan\left(\frac{B_1}{A_1}\right)$$

[0023] If the above technique is used, not only the amplitude information but topology will become possible [acquiring to coincidence] from the wave to which it restored. Compared with the approach which acquired only a part of [wave-like] information like before, recovery information will increase and an opportunity to utilize these effectively will increase. As mentioned above, it becomes possible to solve the various problems resulting from the above-mentioned increment in track density by the multiplexing technique of the servo pattern information by this invention, or positional information.
[0024] Namely, the magnetic-recording medium by which the magnetic storage by this invention has a servo pattern, In the magnetic storage which includes informational writing, the magnetic head which performs read-out, and the servo signal demodulator circuit which recovers a magnetic-head position signal from the regenerative signal of a servo pattern to a magnetic-recording medium The regenerative signal of a servo pattern includes two or more partial signals with which the amplitude and a phase change to coincidence according to the truck cross direction location of the magnetic head. A servo signal demodulator circuit is characterized by restoring to a magnetic-head position signal in quest of the abbreviation coincidence sine wave [each / of two or more of said partial signals] function based on the frequency information on the regenerative signal currently held beforehand.
[0025] A servo demodulator circuit shall ask for the amplitude of each partial signal by adding integral processing to the partial signal concerned, and it shall ask for a phase from the phase of said sinusoidal function. Or a servo demodulator circuit shall ask for the amplitude and phase of each partial signal from said sinusoidal oscillation of a function and phase. As for a servo demodulator circuit, it is desirable to give different weight to the information acquired from the amplitude and the information acquired from a phase, and to restore to a magnetic-head position signal.
[0026] Moreover, the velocity vector of the magnetic head can be obtained using two magnetic-head position signals which only predetermined distance left in the direction of a truck. If the velocity vector of a head travelling direction is known, before resulting in the following servo sector, a head will become possible [presuming whether it is on a predetermined truck] in a data location. If this information is used, when the impact from the outside and vibration will occur during record actuation, consequently a jump of a truck will be expected, destruction of the data of an adjoining truck can be beforehand prevented by forbidding record actuation.
[0027] The magnetic storage by this invention Moreover, the magnetic-recording medium which has a servo pattern, In the magnetic storage which includes informational writing, the magnetic head which performs read-out, and the servo signal demodulator circuit which recovers a magnetic-head position signal from the regenerative signal of a servo pattern to a magnetic-recording medium It is characterized by for said two or more patterns arranging the pattern of two kinds of phase conditions in crosswise [truck], respectively, and constituting them including two or more patterns which shifted the servo pattern in the direction of a truck on both sides of a truck center line, and have been arranged. This servo pattern can be easily formed by the present servo track writer. Pattern chart lasting time is the same as the case of the conventional servo pattern.
[0028] The magnetic storage by this invention Moreover, the magnetic-recording medium which has a servo pattern, In the magnetic storage which includes informational writing, the magnetic head which performs read-out, and the servo signal demodulator circuit which recovers a magnetic-head position signal from the regenerative signal of a servo pattern to a magnetic-recording medium It is characterized by for said two or more patterns arranging the pattern of the phase condition of N (N is three or more positive numbers) class in crosswise [truck], respectively, and constituting them including two or more patterns which shifted the servo pattern in the direction of a truck on both sides of a truck center line, and have been arranged. This servo pattern can be easily formed by the present servo track writer.
[0029] The magnetic storage by this invention Moreover, the magnetic-recording medium which has a servo pattern, In the magnetic storage which includes informational writing, the magnetic head which performs read-out, and the servo signal demodulator circuit which recovers a magnetic-head position signal from the regenerative signal of a servo pattern to a magnetic-recording medium Said two or more patterns are characterized by the phase condition of the direction of a truck being the pattern which changes crosswise [truck] continuously including two or more patterns which shifted the servo pattern in the direction of a truck on both sides of a truck center line, and have been arranged, respectively.
[0030] The magnetic storage by this invention Moreover, the magnetic-recording medium which has a servo pattern and was divided crosswise [truck] in two or more zones, In the magnetic storage which includes informational writing, the magnetic head which performs read-out, and the servo signal demodulator circuit which recovers a magnetic-head position signal from the regenerative signal of a servo pattern to a magnetic-recording medium The regenerative signal of a servo pattern includes two or more partial waves from which the amplitude and a phase change to coincidence according to the truck cross direction location of the magnetic head. The frequencies of a servo pattern regenerative signal differ for every zone, and a servo signal demodulator circuit is characterized by restoring to a magnetic-head position signal in quest of the abbreviation coincidence sine wave [each / of two or more of said partial signals] function based on the frequency information on the servo pattern regenerative signal read from the inside of each zone. Moreover, the frequency of a servo pattern regenerative signal may be changed for every zone and every truck.
[0031]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing. Drawing 1 is the mimetic diagram showing an example and its example of a playback wave of the servo pattern by this invention. In drawing 1 (a) which shows a servo pattern, the direction of a x axis is the transit direction of the magnetic head 10, and the direction of the y-axis is the truck cross direction of the magnetic head 10. In this example, at least, Patterns A and B see in the direction of a x axis like illustration, alternate arrangement is carried out, and the same repeat as the direction of the y-axis is recorded. Pattern P is continuously recorded in the direction of the y-axis if needed.
[0032] Next, the configuration of each pattern is explained. Pattern A is a pattern with which the pattern 11 of the "phase 1" whose width of face of the direction of y is 1/2 of a track pitch Tp, and the pattern 12 of a frequency f, width of face Tp / 2, and "a phase 2" were put in order and combined in the direction of y on the frequency f. That in which the wave had periodicity like all 1 is recorded. The pattern

length L is die length to which the two or more above-mentioned wave-like periods are sufficient for being recorded at least. It is the pattern which Pattern A and the pattern B by which alternate arrangement is carried out put in order the pattern 13 of the "phase 3" whose width of face of the direction of y is 1/2 of a track pitch Tp, and the pattern 14 of a frequency f, width of face Tp / 2, and "a phase 4" in the direction of y on the frequency f to the center line of truck #N, and was combined. The wave of Pattern B and pattern length are the same as that of Pattern A. Pattern P is a frequency f and is the same wave as the above-mentioned patterns 11-14. The phase of Pattern P may be in agreement with either of "phase 1" - "a phase 4", and does not need to be in agreement. Here, the above-mentioned phases 1-4 need to continue at equal intervals. That is, the equal thing of all of the phase contrast of a phase 1 and a phase 2, the phase contrast of a phase 2 and a phase 3, the phase contrast of a phase 3 and a phase 4, and the phase contrast of a phase 4 and a phase 1 is desirable.

[0033] Drawing 1 (b) shows the example of a playback wave reproduced from the magnetic head 10, when the magnetic head 10 moves in the truck #N top of the pattern shown in drawing 1 (a). The playback wave of Patterns P, A, and B turns into a sinusoidal form which all does not have waveform distortion in the ideal condition. Although phase contrast PA and PB is the phase contrast from a pattern A playback wave and the pattern P playback wave of a pattern B playback wave, since taking a difference like PA-PB can also acquire the topology between a pattern A playback wave and a pattern B playback wave, namely, it can acquire it directly also as a phase shift of a pattern B playback wave to a pattern A playback wave, without minding Pattern P, Pattern P becomes unnecessary in that case. However, the device of changing phase spacing of the above-mentioned phase 1 and a phase 2 and phase spacing of a phase 3 and a phase 4 in this case is needed.

[0034] Furthermore, as a development mold of the servo pattern shown in drawing 1 (a), as shown in drawing 1 (c), Patterns C and D may be arranged in the same location as the case of drawing 2 other than Patterns A and B. In this case, the phases of the patterns 15 and 16 which constitute Pattern C are "a phase 5" and "a phase 6", respectively. Similarly, the phases of the patterns 17 and 18 which constitute Pattern D are "a phase 7" and "a phase 8", respectively. "A phase 5", "a phase 6", "a phase 7", and "a phase 8" may be in agreement with "a phase 1", "a phase 2", "a phase 3", and "a phase 4", respectively, and do not need to be in agreement.

[0035] Drawing 1 (d) is an example of a playback wave reproduced from the magnetic head 10, when the magnetic head 10 moves in the truck #N top of the pattern shown in drawing 1 (c). The playback wave of Patterns P, A, B, C, and D turns into a sinusoidal form which all does not have waveform distortion in the ideal condition. phase contrast PA and PB and .... Patterns A and B and .. although it is the phase contrast from the pattern P playback wave of a playback wave, since taking a difference like PA-PB can also acquire the topology between each pattern playback wave, namely, it can be directly acquired also as two phase shifts of a pattern playback wave, without minding Pattern P, Pattern P becomes unnecessary in that case. However, the device of changing phase spacing of the above-mentioned phases 1-4 and phase spacing of phases 5-8 in this case is needed.

[0036] Drawing 4 is the mimetic diagram showing other examples of the servo pattern by this invention, and an example of the playback wave. Drawing 4 (a) shows a servo pattern, the direction of a x axis is the transit direction of the magnetic head 10, and the direction of the y-axis is the truck cross direction of the magnetic head 10. In this example, at least, Patterns A and B see in the direction of a x axis like illustration, alternate arrangement is carried out, and the same repeat as the direction of the y-axis is recorded. Pattern P is continuously recorded in the direction of the y-axis if needed.

[0037] Pattern A is a pattern with which the pattern 41 of the "phase 1" whose width of face of the direction of y is 1/3 of a track pitch Tp, the pattern 42 of a frequency f, width of face Tp / 3, and "a phase 2", and the pattern 43 of a frequency f, width of face Tp / 3, and "a phase 3" were put in order and combined in the direction of y on the frequency f. That in which the wave had periodicity like all 1 is recorded. The pattern length L is die length to which the two or more above-mentioned wave-like periods are sufficient for being recorded at least. It is the pattern which Pattern A and the pattern B by which alternate arrangement is carried out put in order the pattern 44 of the "phase 4" whose width of face of the direction of y is 1/3 of a track pitch Tp, the pattern 45 of a frequency f, width of face Tp / 3, and "a phase 5", and the pattern 46 of a frequency f, width of face Tp / 3, and "a phase 6" in the direction of y on the frequency f to the center line of truck #N, and was combined. The wave of Pattern B and pattern length are the same as that of Pattern A. Pattern P is a frequency f and is the same wave as the above-mentioned patterns 41-46. The phase of Pattern P may be in agreement with either of "phase 1" - "a phase 6", and does not need to be in agreement. Here, the above-mentioned phases 1-6 need to continue at equal intervals. That is, all of the phase contrast of a phase 1 and a phase 2, the phase contrast of a phase 2 and a phase 3, the phase contrast of a phase 3 and a phase 4, the phase contrast of a phase 4 and a phase 5, the phase contrast of a phase 5 and a phase 6, and the phase contrast of a phase 6 and a phase 1 need an equal thing.

[0038] Drawing 4 (b) shows the example of a playback wave reproduced from the magnetic head 10, when the magnetic head 10 moves in the truck #N top of the pattern shown in drawing 4 (a). The playback wave of Patterns P, A, and B turns into a sinusoidal form which all does not have waveform distortion in the ideal condition. Although phase contrast PA and PB is the phase contrast over a pattern A playback wave and the pattern P playback wave of a pattern B playback wave, since taking a difference like PA-PB can also acquire the topology between a pattern A playback wave and a pattern B playback wave, namely, it can acquire it directly also as a phase shift of a pattern B playback wave to a pattern A playback wave, without minding Pattern P, Pattern P becomes unnecessary in that case. However, the device of changing phase spacing of the above-mentioned phase 1, a phase 2, and a phase 3 and phase spacing of a phase 4, a phase 5, and a phase 6 in this case is needed.

[0039] Furthermore, as a development mold of this servo pattern, as shown in drawing 1 , Patterns C and D may be added behind [x direction] Patterns A and B. The servo pattern shown in drawing 4 can be said to be that to which the servo pattern shown in drawing 1 trichotomized one servo pattern to dividing into two crosswise [truck] (the direction of y). By this view, what carried out N division of the one servo pattern crosswise [truck / y] (N is the natural number) can be considered. In addition, when N becomes a sufficiently large number, it almost becomes the servo pattern explained by drawing 5 R> 5 below with equivalence.

[0040] Drawing 5 is the mimetic diagram showing other examples of the servo pattern by this invention, and an example of the playback wave. Drawing 5 (a) shows a servo pattern, the direction of a x axis is the transit direction of the magnetic head 10, and the direction of the y-axis is the truck cross direction of the magnetic head 10. in this example, at least, Patterns A and B see in the direction of a x axis like illustration, alternate arrangement is carried out, and the same repeat as the direction of the y-axis is alike, and is recorded. Pattern P is continuously recorded in the direction of the y-axis if needed.

[0041] Pattern A is a frequency f, for example, is a pattern from which a phase changes continuously in a #N-1 truck location according to the condition and the direction location of y of "a phase 2" in the condition of "a phase 1", and #N truck location. The pattern width of face of the direction of y is equal to a track pitch Tp. The pattern length L is die length to which the two or more above-mentioned wave-like periods are sufficient for being recorded at least. It is the pattern from which Pattern A and the pattern B by which alternate arrangement is

carried out are frequencies f, for example, a phase changes continuously in #N truck location according to the condition and the direction location of y of "a phase 3" to the center line of truck #N in the condition of "a phase 2", and a #N+1 truck location. The pattern width of face of the direction of y is equal to a track pitch Tp, and the pattern length L is die length to which the two or more above-mentioned wave-like periods are sufficient for being recorded at least. Pattern P is a frequency f and is the same sinusoidal wave as the above-mentioned patterns A and B. The phase of Pattern P may be in agreement with either of above-mentioned "a phase 1" - "a phase 3", and does not need to be in agreement. Here, the above-mentioned phases 1-3 need to continue at equal intervals. That is, by Pattern A, a phase changes to the condition of 1 to 2 uniformly, and a phase changes from 2 to the condition of 3 uniformly by Pattern B.
[0042] Drawing 5 (b) shows the example of a playback wave reproduced from the magnetic head 10, when the magnetic head 10 moves in the truck #N top of the pattern shown in drawing 5 (a). The playback wave of Patterns P, A, and B turns into a sinusoidal form which all does not have waveform distortion in the ideal condition. Although phase contrast PA and PB is the phase contrast over a pattern A playback wave and the pattern P playback wave of a pattern B playback wave, since taking a difference like PA-PB can also acquire the topology between a pattern A playback wave and a pattern B playback wave, namely, it can acquire it directly also as a phase shift of a pattern B playback wave to a pattern A playback wave, without minding Pattern P, Pattern P becomes unnecessary in that case. However, the device of changing phase spacing from the phase 1 to the phase 2 of Pattern A and phase spacing from the phase 2 to the phase 3 of Pattern B in this case is needed.
[0043] Furthermore, as a development mold of the servo pattern shown in drawing 5 (a), as shown in drawing 1 (d), the patterns C and D similar to Patterns A and B behind [x direction] Patterns A and B may be arranged. Drawing 6 is drawing explaining an example of the approach of recording the servo pattern shown in drawing 5 (a). Drawing 6 (a) is the top view of a magnetic disk drive. Moreover, drawing 6 (b) is drawing explaining the locus of the servo pattern recorded by the self-head with which the magnetic disk drive is equipped, and the locus of the servo pattern recorded by the exclusive head for servo pattern record.
[0044] The magnetic disk drive 61 is constituted by the magnetic disk 63 which carries out a rotation drive with a spindle motor 62, and the magnetic head 66 driven through the supporter material 65 with a voice coil motor (VCM) 64. Generally, the servo pattern locus 601 by the self-head is recorded in the shape of radii like illustration by the magnetic head 66. Although it is in the length measurement approach in the case of servo record, or the head delivery approach variously and not being illustrated especially, there is a method of driving the head 66 irradiating a laser beam at a part of head supporter material 65, for example, and measuring the length of the absolute location.
[0045] In record of the servo pattern shown in drawing 5 (a), the exclusive head 68 for servo pattern record other than the head 66 of this self-drive is used. The head 68 for servo pattern record is supported by the supporter material 67, and is arranged in a location in which the locus 602 of the recording head has an include angle theta to the locus of the servo pattern record by the self-head 66 (drawing 6 (b)). While a head 66 and a head 68 take a synchronization, Patterns A and B record a desired pattern by recording with a head 68 by recording the pattern P shown, for example in drawing 5 (a) with a head 66.
[0046] Drawing 7 is drawing explaining other examples of the approach of forming the servo pattern by this invention. Unlike the approach of forming in magnetic recording by the magnetic head, the servo pattern formation approach explained here forms a servo pattern using the technique of lithography, as explained until now, it showed the creation process typically to drawing 7 (a) - (h) with the sectional view of a magnetic disk, and showed the perspective view of the servo pattern finally obtained by drawing 7 (i) through this process. This approach is applicable also to any of the servo pattern shown in drawing 1 , drawing 4 , and drawing 5 .
[0047] Drawing 7 (a) The mask for imprinting a servo pattern to a magnetic disk first by - (d) is formed. As shown in drawing 7 (a), laser cutting is carried out to a desired servo pattern configuration by the laser beam 74 from the photoresist 73 side of the mask substrate which applied the chromium layer 72 and the photoresist 73 to the glass substrate 71 in order, respectively. This process can perform La Stampa, such as a compact disk, using the cutting equipment for carrying out cutting creation. Next, as shown in drawing 7 (b), this is developed and chromium etching is performed. Then, it will be etched as the part which process development of drawing 7 (b) was carried out, and was lost shows drawing 7 (c). Finally the desired mask 75 shown in drawing 7 (d) is obtained by removing a photoresist 73 using a remover.
[0048] Next, the above-mentioned mask 75 is used for drawing 7 (e) - (h), a servo pattern is imprinted to a substrate, and the process which creates a magnetic disk with a servo pattern is shown. The glass substrate 76 shown in drawing 7 (e) serves as a substrate ingredient of a magnetic disk, and the photoresist 77 is applied on it. To this, the exposure light 78 is irradiated through the above-mentioned mask 75, and the pattern of a mask 75 is imprinted at a photoresist 77. If this is developed and it etches in reactive ion etching further, as shown in drawing 7 (f), the shape of toothing reflecting a mask pattern will be formed in the front face of a glass substrate 76. Resist removal of this was carried out like drawing 7 (g), sputtering of the magnetic film 79 was carried out, and the magnetic disk shown in drawing 7 (h) was obtained.
[0049] The flat-surface gestalt (gestalt seen from the top face) of Patterns P, A, and B is equivalent to what was shown in drawing 5 (a) at drawing 7 (i). However, with the perspective view shown by drawing 7 (i), the black part of the pattern of drawing 5 (a) is formed as heights 701, and the white part of the pattern of drawing 5 (a) is formed as a crevice 702. If a field is applied to an one direction in accordance with the case of the magnetic disk which has such a cross-section configuration, for example, a disk front face, it will be magnetized so that a space field may be sent from a concavo-convex corner, and will function as a servo pattern like the magnetization pattern shown in drawing 5 (a).
[0050] Although drawing 7 explained the mask formation process, it is also possible to create the same magnetic disk by forming La Stampa like a compact disk and making a disk substrate according to the process of injection molding. Moreover, although it is the explanatory view of projection exposure in drawing 7 (e), it is good also as adhesion exposure to which a mask and a disk substrate are stuck. Furthermore, in drawing 7 (a), although the laser beam is used for cutting, short wavelength beams, such as an electron beam, may be used from a viewpoint of the formation of pattern detailed. Moreover, although here showed the process which imprints a pattern to the magnetic disk through the mask, it is also possible to apply a resist etc. to a magnetic disk and to perform direct laser cutting.
[0051] Drawing 8 is the block diagram showing an example of the servo signal demodulator circuit which restores to a servo pattern regenerative signal and acquires the position signal of the magnetic head. Through amplifier, one is sent to the amplitude detection system 81, and another is sent for the servo pattern regenerative signal reproduced in the magnetic head to the phase detection system 82. By the amplitude detection system 81, full wave rectification of the above-mentioned signal is carried out, and then an integration operator is performed. As a result of being obtained here, 83 (amplitude value) reflects the amplitude value of a servo pattern regenerative signal. Here, the digital signal after A/D is sufficient as the regenerative signal put into the amplitude detection system 81, and it should just

perform a digital integration operator without full wave rectification in this case.
[0052] In the phase detection system 82, wave sampling and wave fitting are performed after A/D conversion, Fourier coefficients are computed, and the phase value 84 is acquired by calculating a wave-like phase value based on it. Specifically as opposed to one wave of the above-mentioned regenerative signal, a wave is incorporated by 8 times as many exaggerated sampling as this. Under the present circumstances, in accordance with the wave-like frequency to incorporate, it is necessary to decide a sampling frequency fs. In other words, the servo signal demodulator circuit has frequency information wave-like in the form of a sampling frequency fs beforehand. Here, discretization Fourier series perform wave fitting and Fourier coefficients are computed. From the obtained Fourier coefficients, a phase value operation is performed and the wave-like phase value 84 is acquired as a result. Detail of the operation in a phase detection system is given below.
[0053] The above-mentioned number of repeats of 8 and position signal wave p (n) is set to 10 for the number (exaggerated measurement size) discretely incorporated to per [one cycle (period)]. However, n is the number of the point incorporating [wave]. It will be set to the following [several 7] if p (n) is expressed with the fourier polynomial representation.
[0054]
[Equation 7]

$$p(n) = A_0 + \left[\sum_{m=1}^{3}\left\{A_m \cdot \cos\left(\frac{n \cdot \pi \cdot m}{4}\right) + B_m \cdot \sin\left(\frac{n \cdot \pi \cdot m}{4}\right)\right\}\right]$$

[0055] Here, discretization Fourier coefficients and m of A0, Am, and Bm are the degrees of the discretization Fourier transform. It turns out that it will be decided that the above-mentioned fourier polynomial will be a meaning if discretization Fourier coefficients are decided. If the sampling data of a pattern playback wave are set to f (n), the fourier coefficient A 0, and Am and Bm will be calculated as shown in [several 8], [several 9], and [several 10].
[0056]
[Equation 8]

$$A_0 = \frac{1}{80}\sum_{n=0}^{79} f(n)$$

[0057]
[Equation 9]

$$A_m = \frac{1}{40}\sum_{n=0}^{79} f(n) \cdot \cos\left(\frac{n \cdot \pi \cdot m}{4}\right)$$

[0058]
[Equation 10]

$$B_m = \frac{1}{40}\sum_{n=0}^{79} f(n) \cdot \sin\left(\frac{n \cdot \pi \cdot m}{4}\right)$$

[0059] The primary fourier coefficient A (m= 1) 1 and information required of calculating B1 can be acquired most easily. In phase detection, the phase contrast from a reference pattern is searched for as the following [several 11].
[0060]
[Equation 11]

$$\arctan\left(\frac{B_1}{A_1}\right)$$

[0061] Drawing 9 is the block diagram showing other examples of the servo signal demodulator circuit which restores to a servo pattern regenerative signal and acquires the position signal of the magnetic head. The servo pattern regenerative signal reproduced in the magnetic head incorporates a wave by 8 times as many exaggerated sampling as this through an amplifier and an A/D converter as opposed to one of them. Under the present circumstances, in accordance with the wave-like frequency to incorporate, it is necessary to decide a sampling frequency fs. In other words, the servo signal demodulator circuit has frequency information wave-like in the form of a sampling frequency fs beforehand. Here, discretization Fourier series perform wave fitting and Fourier coefficients are computed.
[0062] From the obtained Fourier coefficients, a wave-amplitude value operation and a phase value operation are performed, and amplitude value 91 and the phase value 92 are acquired as a result, respectively. Specifically according to the flow of the operation from the above [several 7] to [several 10], it asks for Fourier coefficients. A required result can be most easily obtained by calculating the primary fourier coefficient A (m= 1) 1 and B1. Here, in phase detection, amplitude value 91 is calculated as shown in [several 12], and in amplitude detection, the phase contrast 92 from a reference pattern can be calculated as shown in [several 11], and it can search for it, respectively.
[0063]
[Equation 12]

$$\sqrt{(A_1)^2 + (B_1)^2}$$

[0064] The amplitude value 83 outputted from the servo signal demodulator circuit shown in drawing 8 , the phase value 84, and the amplitude value 91 and the phase value 92 which are outputted from the servo signal demodulator circuit shown in drawing 9 express the position signal (POS) of the magnetic head, respectively. One linearity position signal is acquired by distributing this if needed.

[0065] The allocation approach of the position signal using amplitude information and the position signal by topology is explained using drawing 10 . The patterns P, A, and B shown in drawing 10 (a) are patterns already explained by drawing 1 R> 1, drawing 3 , drawing 4 , and drawing 5 . The result of having carried out the pattern recovery of A and the B pattern regenerative signal is set to PA and PB to SA, SB, and a phase recovery in the servo signal demodulator circuit shown in drawing 8 or drawing 9 to an amplitude recovery. At this time, P expressed with Q expressed with the following [several 13] and [several 14] becomes the position signal of the amplitude and each phase.
[0066]
[Equation 13] Q=SA-SB [0067]
[Equation 14] P=PA-PB [0068] Each position signal Q and P serves as a wave shown in drawing 10 R> 0 (b). Next, standardization signal Q#POS of Q and P and P#POS are computed as shown in following [several 15] and [several 16]. w is the weight for making signal level of the amplitude and a phase equivalent among a formula.
[0069]
[Equation 15]

$$Q\_POS = \frac{(1+w)\cdot Q}{|Q+w\cdot P|}$$

[0070]
[Equation 16]

$$P\_POS = \frac{(1+w)\cdot P}{|Q+w\cdot P|}$$

[0071] Thus, it is a standardization position signal, and Q#POS and P#POS which were calculated extract these straight-line fields, and use it for a position signal (part pinched by O of drawing 10 (c) (it is a range display with an arrow head)). A standardization signal may be computed again, as shown in following [several 17] and [several 18]. n is a positive number among a formula.
[0072]
[Equation 17]

$$Q\_POS = \frac{\sqrt[n]{1+w^n}\cdot Q}{\sqrt[n]{Q^n + w^n\cdot P^n}}$$

[0073]
[Equation 18]

$$P\_POS = \frac{\sqrt[n]{1+w^n}\cdot P}{\sqrt[n]{Q^n + w^n\cdot P^n}}$$

[0074] Thus, the signal of the amplitude and each phase can be reproduced, it can get over, and a position signal with good linearity can be acquired by using complementary combining it. That is, by restoring to the servo pattern shown in drawing 1 (a) or drawing 1 (c), the servo pattern shown in drawing 4 (a), and the servo pattern shown in drawing 5 in the servo signal demodulator circuit of this invention, and acquiring amplitude information and topology, linearity is good and the position signal excellent in the noise-proof engine performance can be acquired. And if playback wave-amplitude information and topology are used complementary, since the linearity of all fields is securable with the servo pattern which consists of patterns A and B shown in drawing 1 (a) etc., the patterns C and D as shown in drawing 1 (c) are necessarily unnecessary. That is, according to this invention, the monopoly area of a servo pattern can be reduced using the servo pattern which consists of patterns A and B, securing linearity. In other words, it will be possible to make a data area rate increase, and it will contribute to improvement in format effectiveness.
[0075] Drawing 11 explains other examples of this invention. Here, when vibration or an impact joins a magnetic disk drive from the exterior and a jump arises in the tracking of the magnetic head under the effect, how to foreknow it from a servo recovery signal is explained.
[0076] In addition to the patterns P, A, and B explained until now, drawing 11 (a) repeats and records the same pattern A' as A and B, and B'. Position signal generation of the magnetic head is possible by the approach explained until now using P, A, and B pattern. Now, vibration or an impact is added from the exterior of a magnetic disk drive, and suppose that it moved as the locus of the magnetic head showed by the arrow head 111 by the effect. In this case, the amount of location gaps of delta 1 arises between the location 112 which computes a head position from A and B pattern, and the location 113 which computes a head position from A' and B' pattern. Since this amount of location gaps is observed by the position signal to which it restores with A, B pattern, and A' and B' pattern, respectively and the pass time from a location 112 to a location 113 is also known on the other hand, the sense and magnitude of a vector of a locus 111 are calculable.
[0077] Drawing 11 (b) indicates how to acquire the same effectiveness by different pattern arrangement to be drawing 11 (a). The pattern shown in drawing 11 (b) adds the field of R1 and R2 to the patterns P, A, and B explained until now. In addition, A on one truck, R1 and R1, and B and R2 are the same patterns, respectively, and the field of R1 and R2 is the pattern which continued over the truck cross direction. Position signal generation is possible by the approach explained until now using P, A, and B pattern. Especially the position signal by the phase pattern becomes possible [also using P and R1].
[0078] Now, vibration or an impact joins a magnetic disk drive from the exterior, and suppose that it moved as the locus of the magnetic head showed by the arrow head 114 by the effect. In this case, the amount of location gaps of delta 2 arises between the location 115 which computes a head position from P and R1 pattern, and the location 116 which computes a head position from P and R2 pattern. Since this amount of location gaps is observed by the position signal to which it restores with P and R1 pattern and P and R2 pattern, respectively and the pass time from a location 115 to a location 116 is also known on the other hand, the sense and magnitude of a vector

of a locus 114 are calculable.
[0079] If the approach explained by drawing 11 (a) or (b) shows the velocity vector of a head travelling direction, before resulting in the following servo sector, a head will become possible [presuming whether it is on a predetermined truck] in a data location. When the impact from the outside and vibration occur during record actuation, such presumption is needed in order to avoid the danger of destroying the data of an adjoining truck. If it is presumed that there is no head location in a data area on a predetermined truck, destruction of data can be beforehand prevented by forbidding record actuation, for example. That is, it contributes to the improvement in dependability of a magnetic disk drive.
[0080] Drawing 12 is drawing explaining the example of further others of this invention. Drawing 12 expresses typically the format configuration of the servo information by this invention, and a data area, the longitudinal direction of drawing is the head transit direction, and the vertical direction is the truck cross direction. As an example of a servo information configuration, there are 123 and the servo marks 124 by this invention explained so far, such as the PLL section 121, the address mark (AM) 122, and a cylinder number, and data 125 are added to it, it becomes 1 servo sector, a servo sector is repeated, and one truck is constituted. The count of a servo sector repeat is about 150 times from 50 times.
[0081] Now, thousands of above-mentioned several 100- trucks are collected, and constitute Zone N. Applying to a periphery from disk inner circumference, the number of a zone is five to about 30. Record frequencies of the pattern in 123, such as the PLL section 121 in each zone, the address mark (AM) 122, and a cylinder number, are fixed at f0. On the other hand, it is Zone N, N+1, and N+2.... The record frequencies of the servo mark 124 differ, respectively. each zone N, N+1, and N+2 -- the information about the record frequency of a servo mark 124 which is different in every .... can respond to the record frequency change for every zone by making it correspond to a cylinder number 123, recording a table which gives the sampling frequency of every zone on ROM etc., and sampling with a predetermined sampling frequency to the cylinder which the magnetic head accesses.
[0082] Desirably, the record frequency of a periphery side zone is high, and its lower one is [the record frequency of an inner circumference side zone] good. Furthermore, it is good desirably to define a record frequency based on the following views. According to the record capacity of a head and a medium, the playback wave of the pattern by which magnetic recording within a field was carried out serves as a solitary wave with wave-like narrow half-value width (PW50 value), when recording density is comparatively low. A wave becomes close to a sinusoidal configuration gradually as a record frequency is raised and recording density becomes high. If wave-like frequency spectrum is seen, as for a solitary wave, in addition to a fundamental-wave component, much harmonic content after second will be observed. On the other hand, at the time of a position signal wave recovery, only the frequency of the fundamental-wave circumference filtering and cutting the component of a high region from the purpose of a high region and low-pass noise reduction, is usually performed. It is the case where selection of the good record frequency of energy efficiency with few cuts of a high-frequency component is desired from this, and about 3 times of half-value width (PW50 value) when the value records a solitary wave become a wave-copy period (inverse number of a record frequency) (IEEE Transaction on Magnetics, 32-5, pp.3899-3901 (1996)). Therefore, it is good to decide the record frequency of each zone so that about 3 times of the half-value width (PW50 value) when recording a solitary wave on each zone may become a wave-copy period (inverse number of a record frequency). According to this approach, it becomes possible to acquire the recovery wave of a servo signal in the condition with the most sufficient energy efficiency, the quality of a position signal can be kept good, and, finally, positioning accuracy will improve. The further above-mentioned view may be applied for every zone and every truck.
[0083] Next, drawing 13 and drawing 14 explain an example of the magnetic disk drive by this invention, and an internal circuitry. Drawing 13 (b) shows the A-A' cross section of (a) for the top view of a magnetic disk drive [in / in drawing 13 (a) / this invention] typically, respectively. The magnetic head 131 is driven with the head actuator 133 containing a voice coil motor (VCM) through the head supporter material 132. On the other hand, a magnetic disk 134 is driven with a spindle motor 136 through the disk spindle 135. The above component part is carried in the base 137, and is sealed with covering 138. Moreover, I/O of record and playback, its control and the point to point control of the magnetic head, power control, data, a control signal, power, etc., etc. is performed in the circuit carried in the circuit board 139.
[0084] Drawing 14 is the functional block diagram which expressed the work inside the above-mentioned circuit typically. Power 1315 is outputted [a controller 1303, address information 1313, and status information 1314 are outputted and inputted by the positioning circuit section 1304, and / the magnetic data information 1311 is begun and input/output control of the control signal 1312, address information 1313 and status information 1314, and power 1315 I/O is carried out by the interface circuitry 1301, and] the magnetic data information 1311 and inputted for record / regenerative-circuit system 1302, and a control signal 1312 by the power controller 1305, respectively. A spindle and each circuit drive with the power supplied from the power controller 1305 (1316 1317), and a head actuator drives using the servo information 1318 from the positioning circuit section 1304. Record/playback information 1319 is exchanged from record / regenerative-circuit section 1302 through the magnetic head 1307 to a magnetic disk 1306. Here, the location by the positioning approach by this invention and the rate information 1320 are changed into the servo information 1318 in the positioning circuit section 1304, and also control information 1321 is sent to a controller and used for control of record / regenerative-circuit section 1302.
[0085]
[Effect of the Invention] According to this invention, the approach and equipment which have been improved more can be offered to the inhibition factor of increments in track density, such as non-linearity of the position signal actualized as the track density of magnetic storage increases, a fall of a signal-to-noise ratio (S/N), and a fall of the oscillating (disturbance vibration) proof stress from the outside, and it can contribute to the increment in storage capacity of magnetic storage.

[Translation done.]

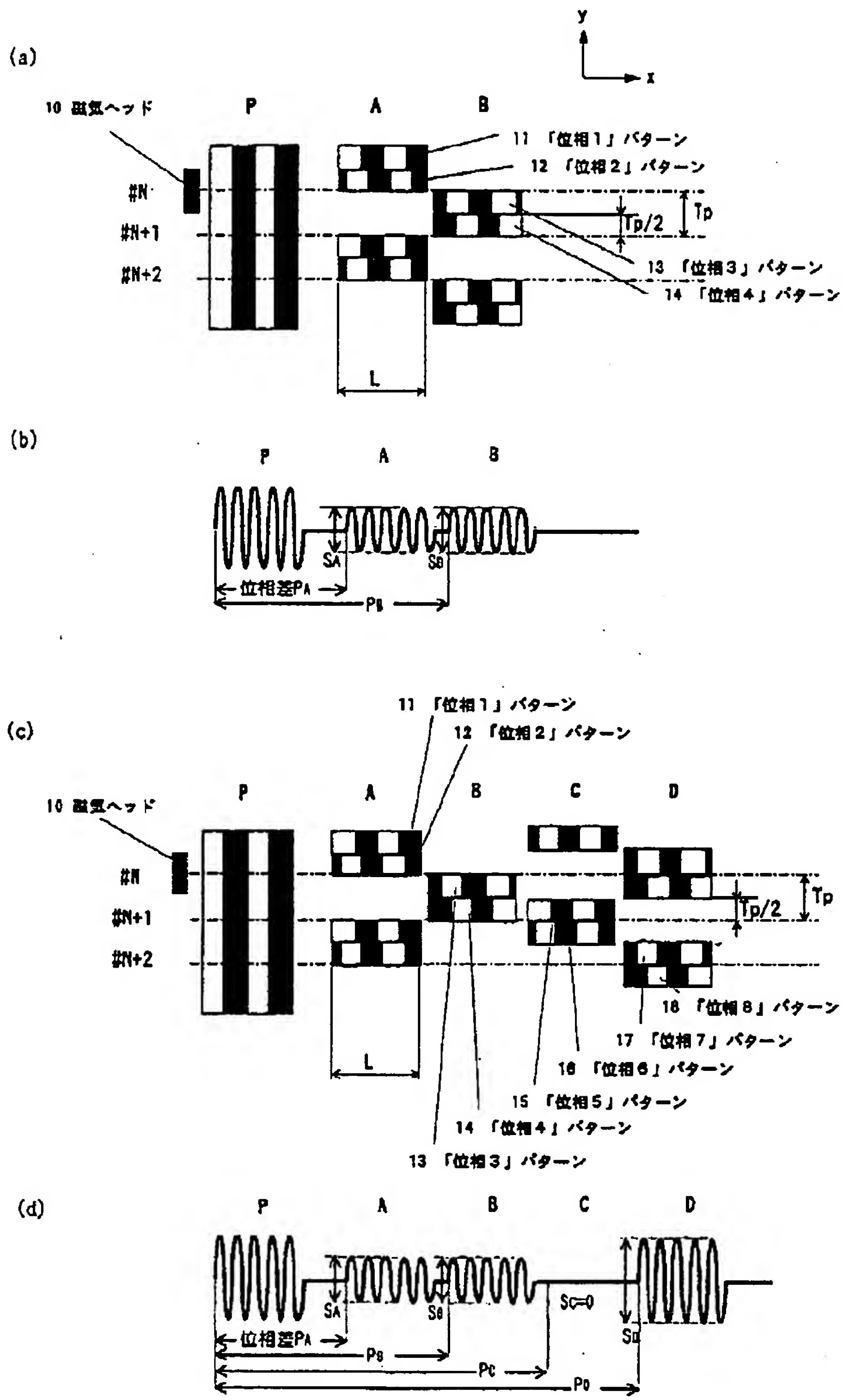
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The mimetic diagram showing an example and its example of a playback wave of the servo pattern by this invention.
[Drawing 2] Drawing explaining the outline of the conventional "amplitude detection servo" method.
[Drawing 3] Drawing explaining the outline of the conventional "phase detection servo" method.
[Drawing 4] The mimetic diagram showing other examples of the servo pattern by this invention, and an example of the playback wave.
[Drawing 5] The mimetic diagram showing other examples of the servo pattern by this invention, and an example of the playback wave.
[Drawing 6] Drawing explaining an example of the approach of recording the servo pattern shown in drawing 5 (a).
[Drawing 7] Drawing explaining other examples of the approach of forming the servo pattern by this invention.
[Drawing 8] The block diagram showing an example of a servo signal demodulator circuit.
[Drawing 9] The block diagram showing other examples of a servo signal demodulator circuit.
[Drawing 10] Drawing explaining the allocation approach of the position signal using amplitude information, and the position signal by topology.
[Drawing 11] Drawing for explaining the velocity vector detection approach of the magnetic head.
[Drawing 12] Drawing showing the format configuration of the example which changes the record frequency of a servo mark for every zone.
[Drawing 13] The schematic diagram of the magnetic disk drive by this invention.
[Drawing 14] The functional block diagram explaining an example of the internal circuitry of a magnetic disk drive.
[Description of Notations]
10 -- The magnetic head, 11 -- The pattern of "a phase 1", 12 -- The pattern of "a phase 2", 13 -- The pattern of "a phase 3", 14 -- The pattern of "a phase 4", 15 -- The pattern of "a phase 5", 16 -- The pattern of "a phase 6", 17 -- The pattern of "a phase 7", 18 -- The pattern of "a phase 8", 41 -- The pattern of "a phase 1", 42 -- The pattern of "a phase 2", 43 -- The pattern of "a phase 3", 44 -- The pattern of "a phase 4", 45 -- The pattern of "a phase 5", 46 -- The pattern of "a phase 6", 61 -- A magnetic disk drive, 62 -- A spindle motor, 63 -- Magnetic disk, 64 [-- Supporter material,] -- A voice coil motor, 65 -- Supporter material, 66 -- The magnetic head, 67 68 -- The head for servo pattern record, 601 -- A servo pattern, 602 -- The locus of a recording head, 71 [-- Laser beam,] -- A glass substrate, 72 -- A chromium layer, 73 -- A photoresist, 74 75 [-- Exposure light,] -- A mask, 76 -- A glass substrate, 77 -- A photoresist, 78 79 [-- An amplitude detection system 82 / -- Phase detection system,] -- A magnetic film, 701 -- Heights, 702 -- A crevice, 81 83 [-- A phase value 111 / -- The locus of the magnetic head,] -- Amplitude value, 84 -- A phase value, 91 -- Amplitude value, 92 112 -- The location, 113 which compute a head position from A and B pattern -- A', the location which computes a head position from B' pattern, 115 -- The location, 116 which compute a head position from R1 pattern -- The location which computes a head position from R2 pattern, 121 -- The PLL section, 122 -- The address mark, 123 -- Cylinder number etc., 124 [-- Supporter material,] -- A servo mark, 125 -- Data, 131 -- The magnetic head, 132 133 -- A head actuator, 134 -- A magnetic disk, 135 -- Disk spindle, 136 [-- Circuit board,] -- A spindle motor, 137 -- The base, 138 -- Covering, 139 1301 -- An interface, 1302 -- Record / regenerative-circuit section, 1303 -- Controller, 1304 -- The positioning circuit section, 1305 -- A power controller, 1306 -- Magnetic disk, 1307 -- The magnetic head, 1311 -- Magnetic data information, 1312 -- Control signal, 1313 [-- A spindle drive 1317 / -- Each circuit drive, 1318 / -- Servo information, 1319 / -- Record/playback information, 1320 / -- A location, rate information, 1321 / -- Control information] -- Address information, 1314 -- Status information, 1315 -- Power, 1316

[Translation done.]

DRAWINGS

[Drawing 1]



(a)
y
x
10 磁気ヘッド
P
A
B
11 「位相1」パターン
12 「位相2」パターン
#N
#N+1
#N+2
Tp/2
Tp
13 「位相3」パターン
14 「位相4」パターン
L
(b)
P
A
B
SA
SB
位相差PA
PB
(c)
11 「位相1」パターン
12 「位相2」パターン
10 磁気ヘッド
P
A
B
C
D
#N
#N+1
#N+2
Tp/2
Tp
18 「位相8」パターン
17 「位相7」パターン
16 「位相6」パターン
15 「位相5」パターン
14 「位相4」パターン
13 「位相3」パターン
L
(d)
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A
B
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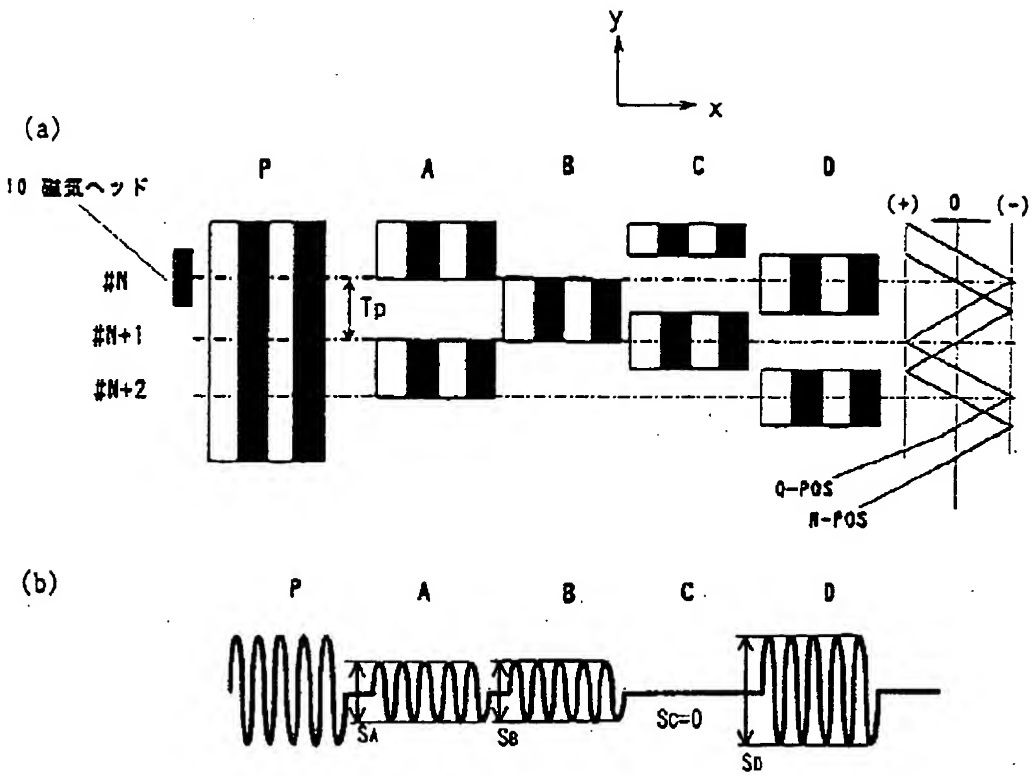
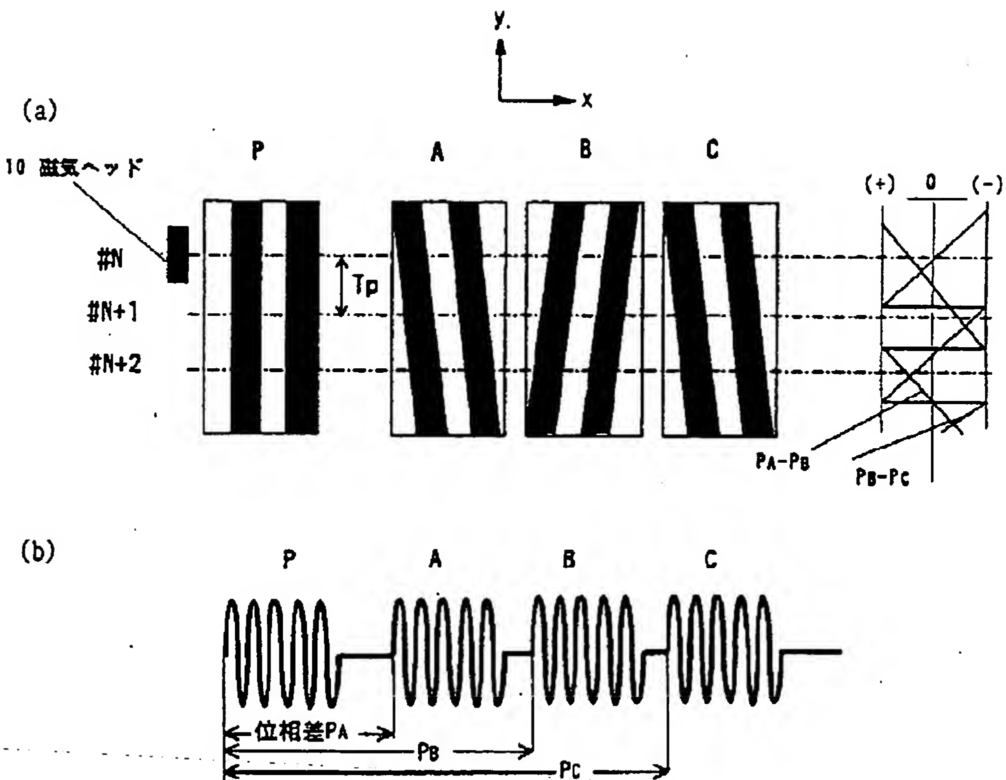
SD
位相差PA
PB
PC
PD

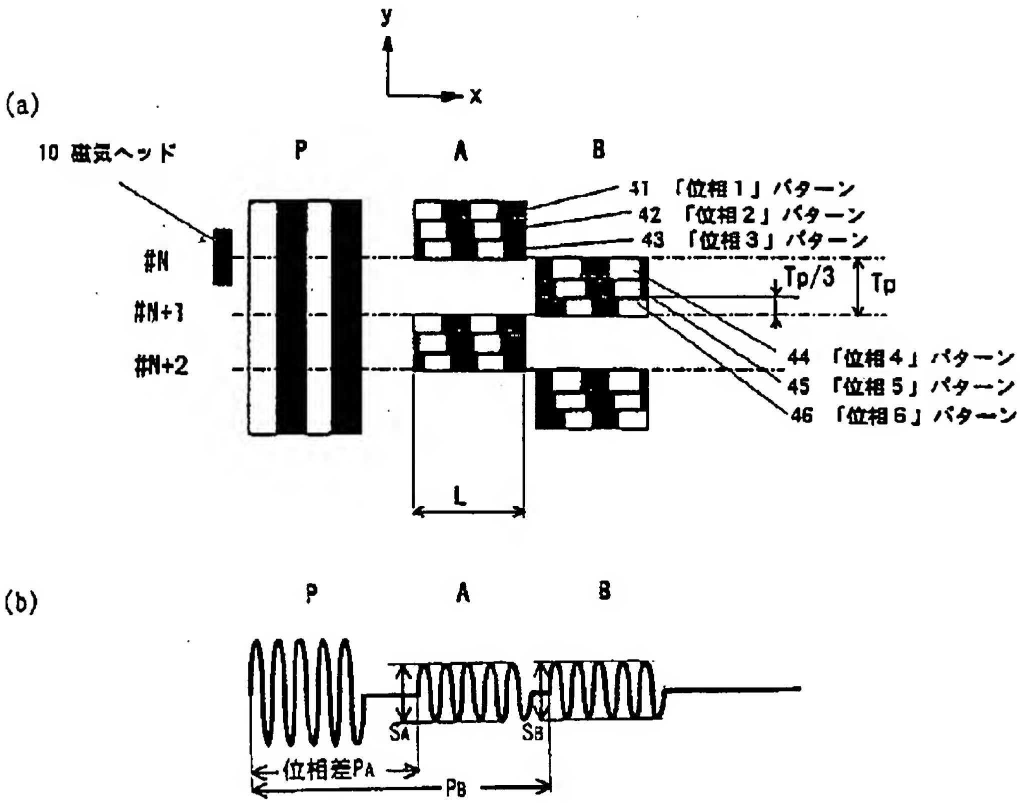
[Drawing 2]



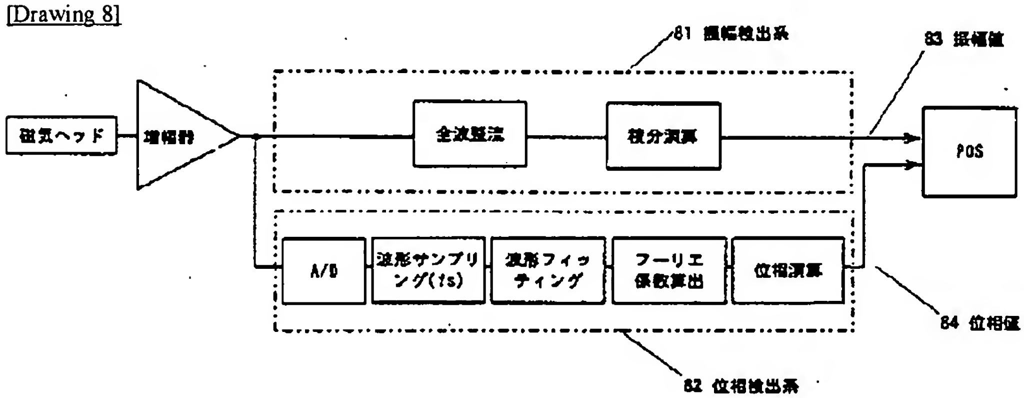
[Drawing 3]



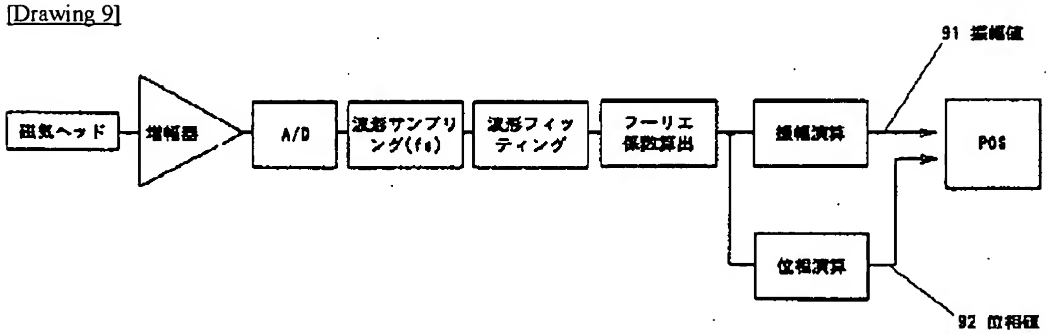
[Drawing 4]



[Drawing 8]

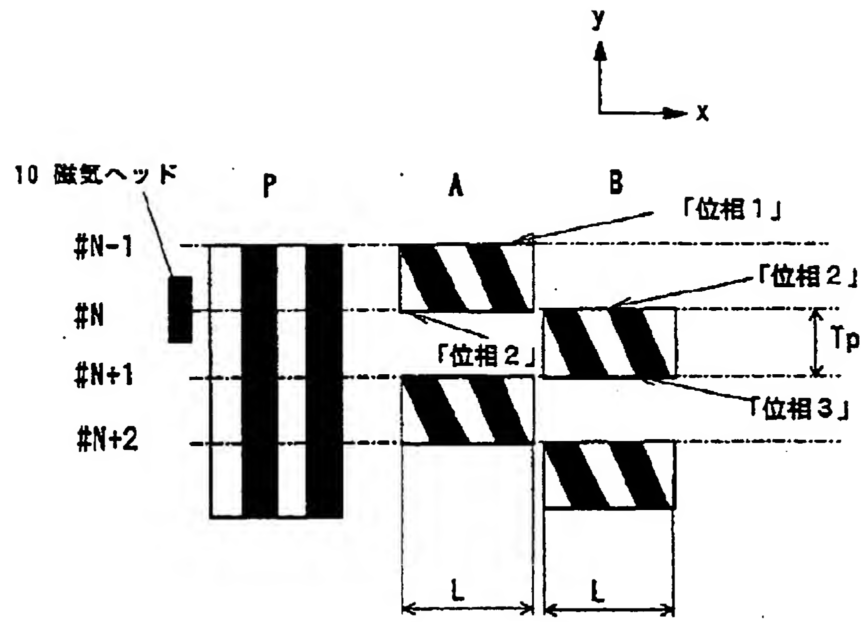


[Drawing 9]

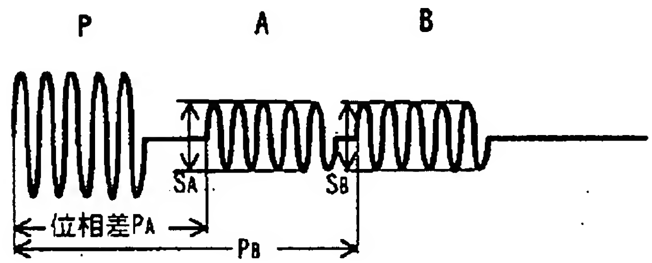


[Drawing 5]

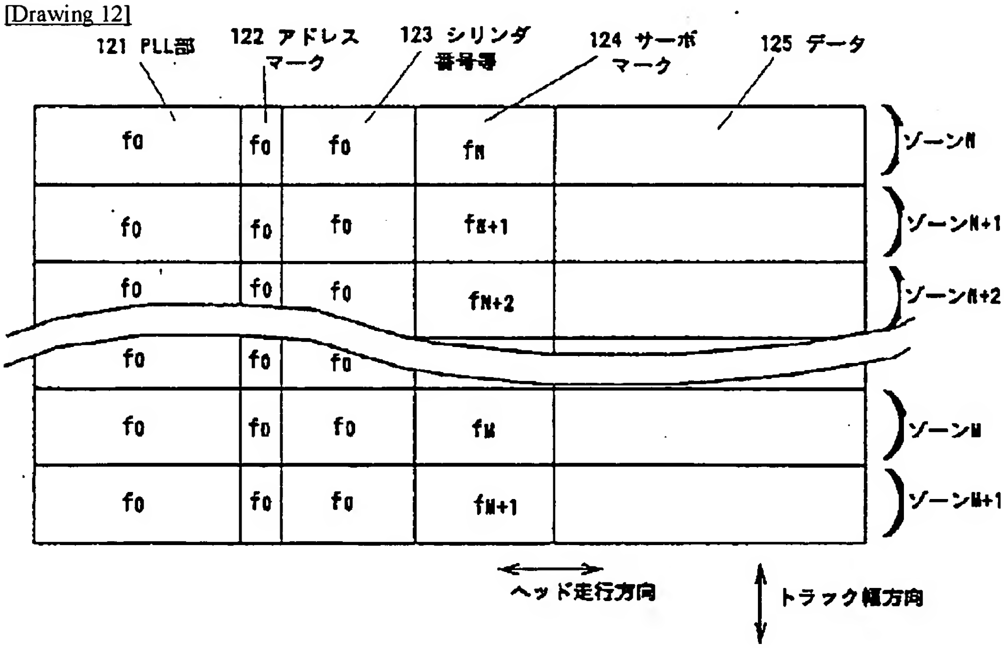
(a)



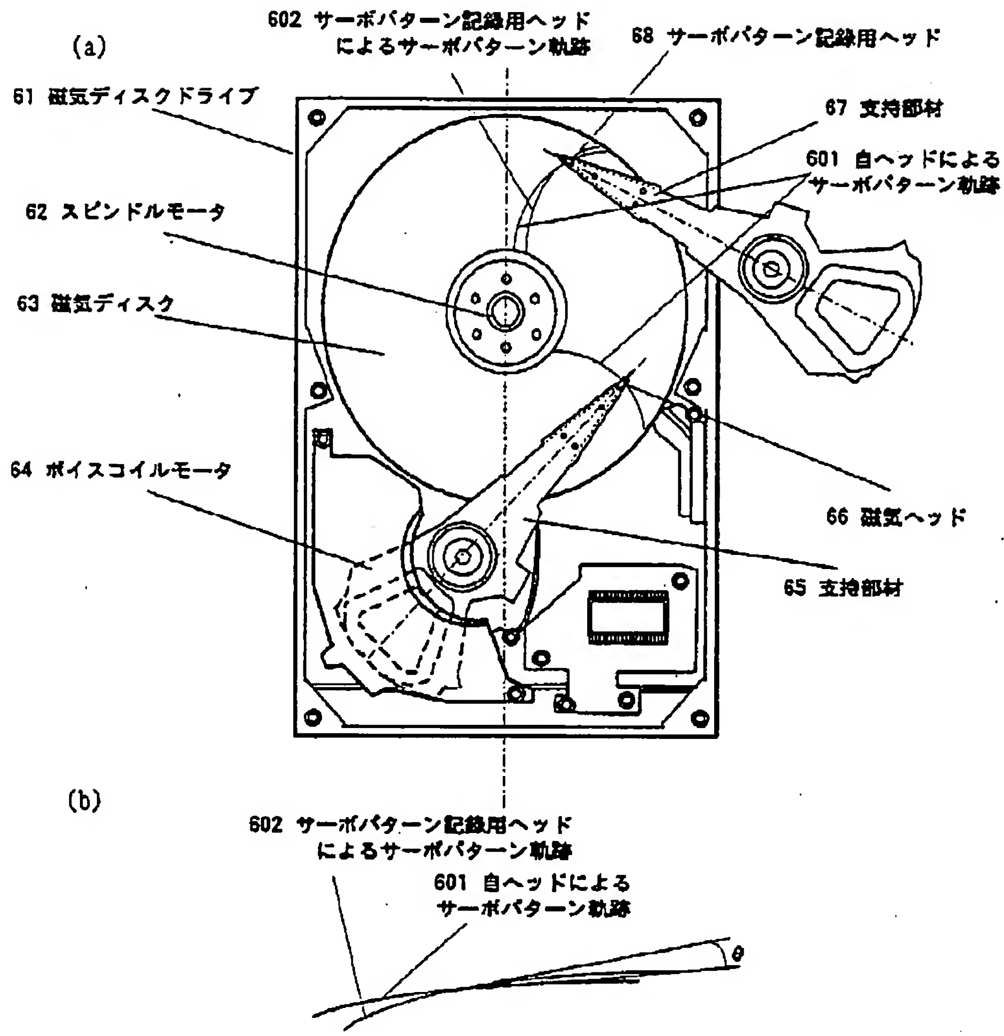
(b)



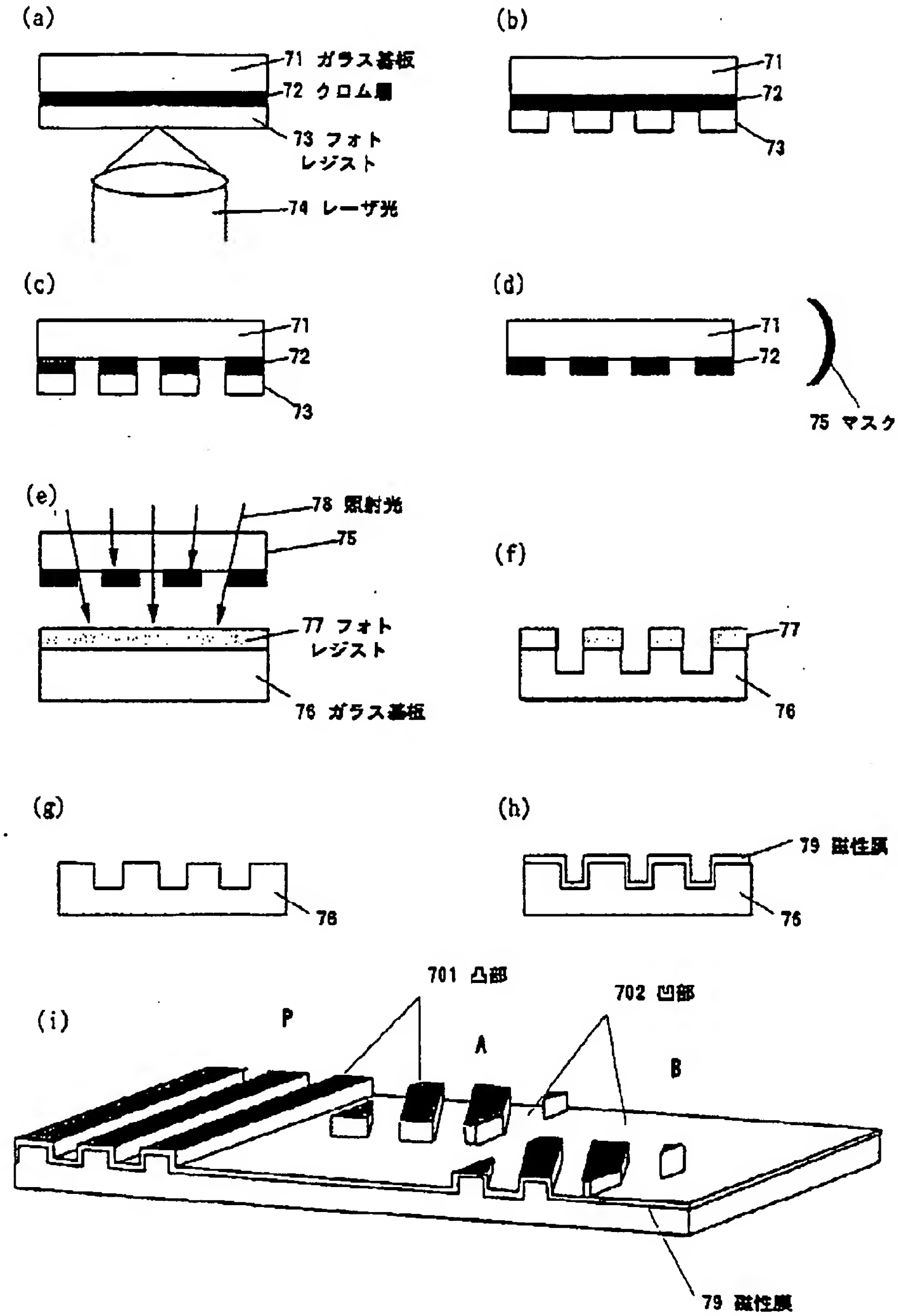
[Drawing 12]



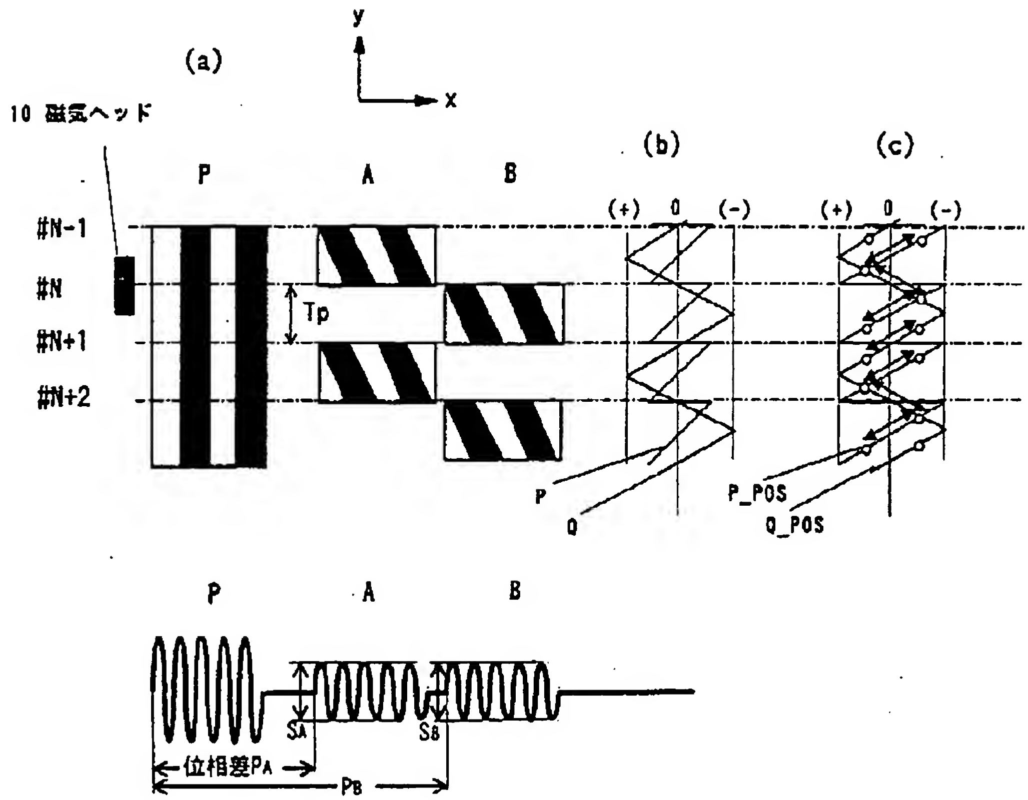
[Drawing 6]


(a)
602 サーボパターン記録用ヘッドによるサーボパターン軌跡
68 サーボパターン記録用ヘッド
61 磁気ディスクドライブ
67 支持部材
601 自ヘッドによるサーボパターン軌跡
62 スピンドルモータ
63 磁気ディスク
64 ボイスコイルモータ
66 磁気ヘッド
65 支持部材
(b)
602 サーボパターン記録用ヘッドによるサーボパターン軌跡
601 自ヘッドによるサーボパターン軌跡
θ

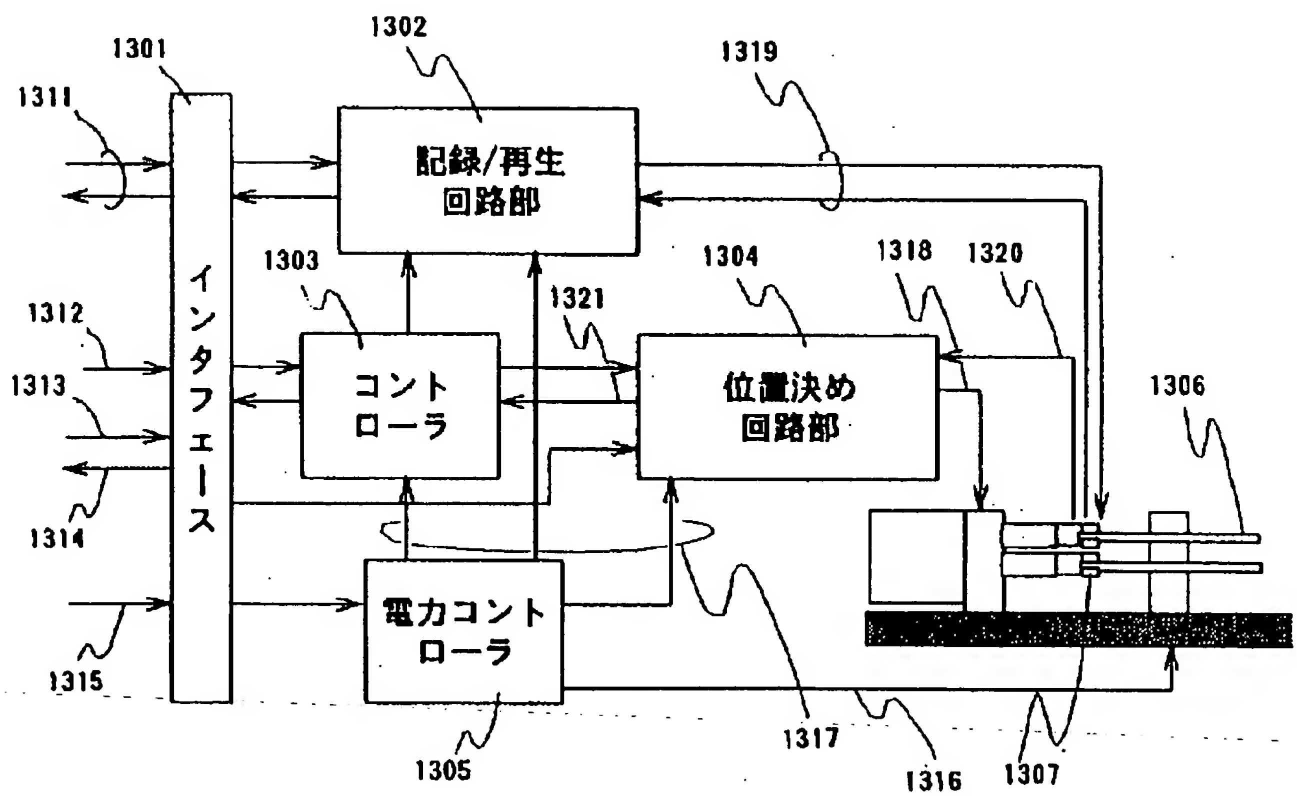
[Drawing 7]


(a)
71 ガラス基板
72 クロム膜
73 フォト レジスト
74 レーザ光
(b)
71
72
73
(c)
71
72
73
(d)
71
72
75 マスク
(e)
78 照射光
75
77 フォト レジスト
76 ガラス基板
(f)
77
76
(g)
76
(h)
79 磁性膜
76
(i)
701 凸部
702 凹部
P
A
B
79 磁性膜

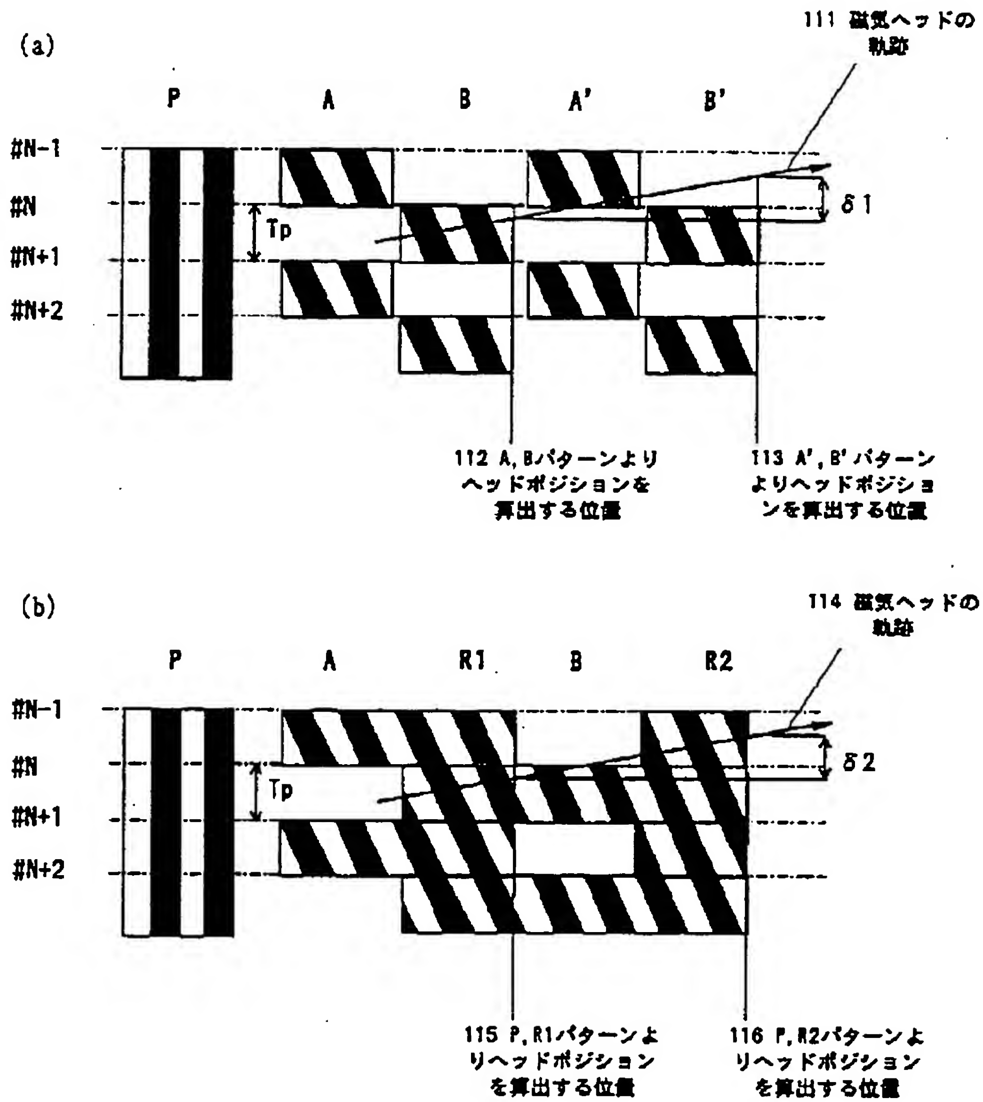
[Drawing 10]



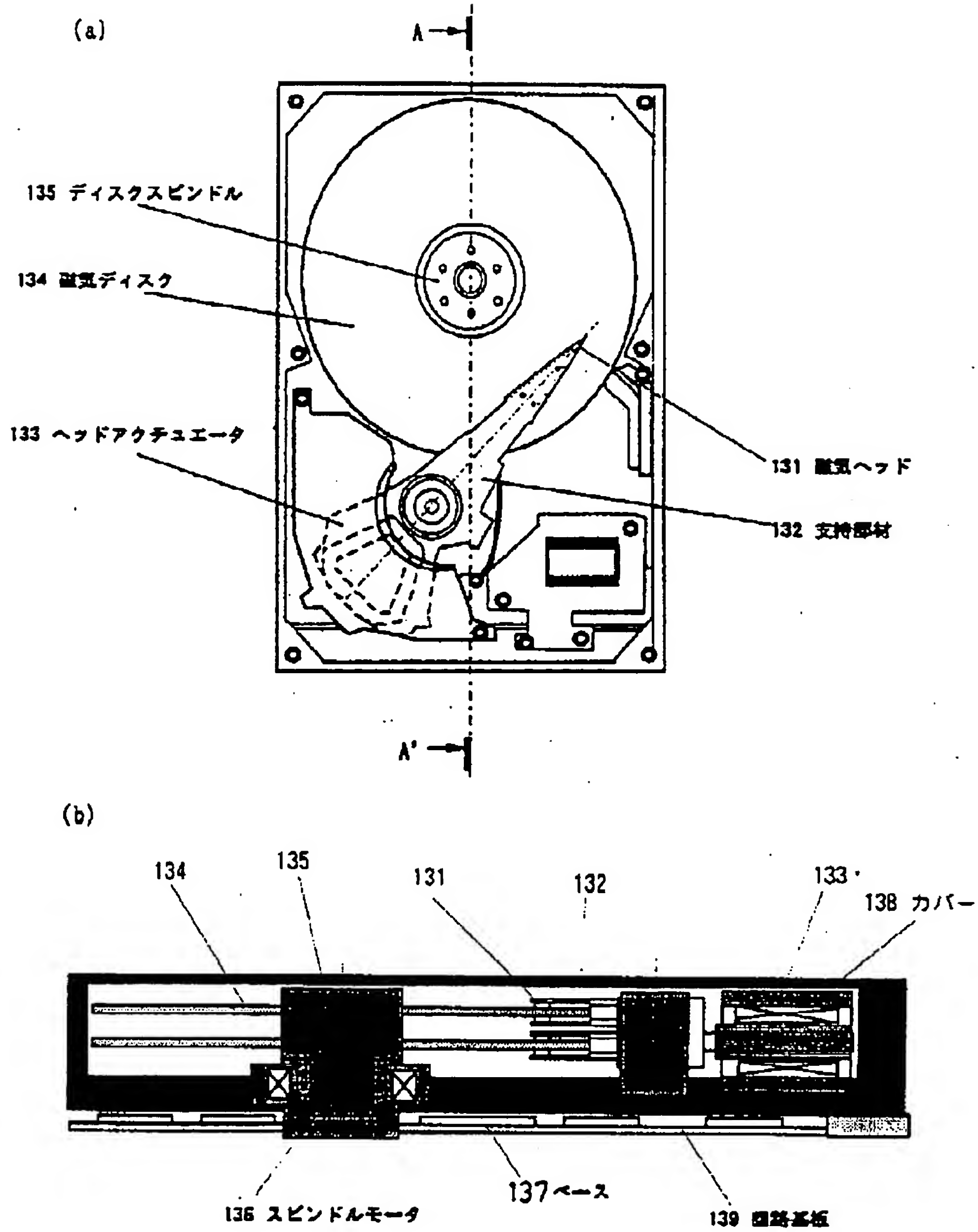
[Drawing 14]



[Drawing 11]


(a)
111 磁気ヘッドの軌跡
P
A
B
A'
B'
#N-1
#N
#N+1
#N+2
Tp
δ1
112 A, Bパターンよりヘッドポジションを算出する位置
113 A', B' パターンよりヘッドポジションを算出する位置
(b)
114 磁気ヘッドの軌跡
P
A
R1
B
R2
#N-1
#N
#N+1
#N+2
Tp
δ2
115 P, R1パターンよりヘッドポジションを算出する位置
116 P, R2パターンよりヘッドポジションを算出する位置

[Drawing 13]



[Translation done.]